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APPLICATION OF SIMULATION AND THEORY OF CONSTRAINTS (TOC) TO SOLVE LOGISTICS PROBLEM IN A STEEL PLANT

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ABSTRACT

This case deals with the inbound logistics of raw material coming to Coke Plant of a Steel Plant located in eastern India. The said plant was having problem of payment of huge demurrage charges to railways due to higher cycle time of wagon unloading which further affected the downstream process and raw material inventory. A study was initiated to solve these problems using TOC and simulation to optimize the raw material value chain. Various enablers and their impact was assessed using simulation and the best of them were implemented by the team to achieve desired results. Apart from this, operation philosophy was fully overhauled solely based on the evaluation by simulation. Finally, there was a significant improvement in cycle time which led to reduction of demurrage and improvement in operations. This showed the power of simulation to influence the decision making without causing disruption in a running plant.

1 INTRODUCTION

This The plant under discussion produces 1.6 MT/year of Coke for consumption in a Steel Plant located in eastern India. The coke plant requires ~2.4 MT/year of Coal as raw material for conversion into coke. The coal comes in railways' rakes to the plant which is unloaded using a tippler into a hopper, further going to stockyard through network of conveyors. It is later reclaimed using reclaimer machine to fill the coal bins via operation of crushing to go for processing.

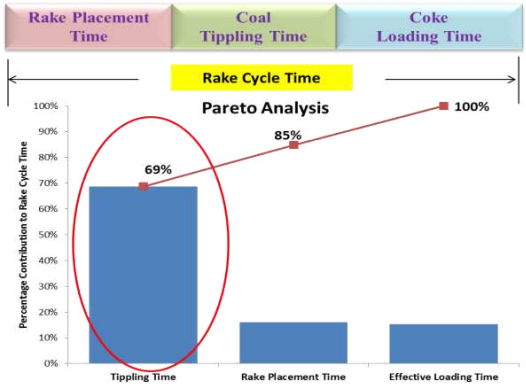

Fig. 1: Problem Identification

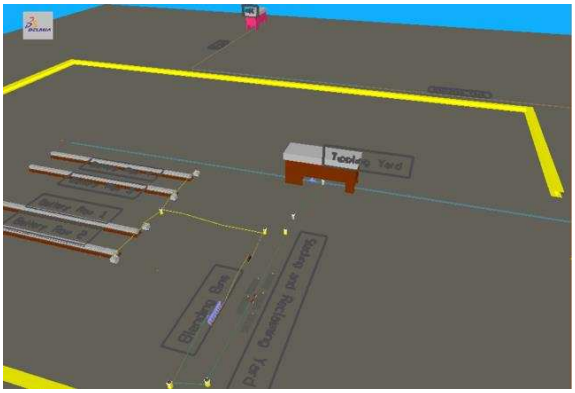

Fig.2: Simulation Model with Delmia Quest

This plant was facing problem of high demurrage by railways due to very high rake cycle time. This problem was linked to low tippling time as found from initial data analysis as shown in the figure 1. The root cause of the problem came out to be tippling time and entire study was focused around this problem.

2 METHODOLOGY

Conventional Industrial Engineering technique of time study was used to capture the detailed timings of various steps involved in the process. Theory of Constraints (TOC) was used to identify the constraints in the raw material value chain and tackle them using various technical solutions. To check the adequacy and impact of the enablers on the system we used the technique of Discrete Event Simulation (DES). Delmia QUEST V22 has been used for modeling the system (Fig. 2) along with analysis in Statistica. The data on railway arrival were fitted using standard data fitting Chi square model to be fed into the DES model. During the study, it was also observed that there was no standardized operating philosophy and mostly dependent on operator's skill. In order to address this issue we developed an optimal standard operating model for coal reclaiming process and circuit operation based on coal bins level and operation time. The adequacy of this model was checked using DES for any abnormalities and found satisfactory.

3 RESULTS AND CONCLUSIONS

Various enablers were proposed to enhance the throughput and decrease the cycle time. Some of those are mentioned below:

1. Side Arm Charger movement of the tippler and arm lifting-lowering speed were benchmarked with the one operating at similar plant. OEM provided with the desired changes in the machine
2. To increase the evacuation rate from ground hoppers, the speed of middle hopper vibro-feeder was to be increased to 600 tph from the existing 400 tph.
3. To Increase reclaiming rate of the coal stacker-cum-reclaimer with the help of OEM intervention.

The summary of changes are shown below:

As Is Condition:

Tippling Rate	Reclaiming Rate		Ground Hopper Loading	Operating Logic	Avg Tippling Time	Ground Dumping
	Actual	Effective				
12 wagons per hour	600 TPH	450 TPH	Uneven (25:50:25)	Operator Based	8.5 Hours	~ 18x Tons/month

Expected Improvement on Implementation (Based on Simulation Result):

Tippling Rate	Reclaiming Rate		Ground Hopper Loading	Operating Logic	Avg Tippling Time	Ground Dumping
	Actual	Effective				
15 wagons per hour	750 TPH	600 TPH	Even	Standard Logic	5.8 Hours	~ x Tons/month
15 wagons per hour	600 TPH	450 TPH	Even	Standard Logic	6.4 hours	~ 3x Tons/month

Simulation proved to be an efficient tool for this study wherein we used it for enhancing throughput. There was an improvement of 20% in unloading cycle time which resulted in savings in demurrage. There was also a standardization of operating logic which was tested using DES for any flaws and it has proved to be a boon for the operation team. So this case study proves the capability of simulation to handle multi-dimensional industrial problems like throughput enhancement, operation excellence, scenario analysis etc.

REFERENCES

Bzymek, Z. M., Nunez, M., Li, M., & Powers, S. (2008). Simulation of a machining sequence using delmia/quest software. Computer-Aided Design and Applications, 5(1-4), 401-411.